AUSTRALIAN FRESHWATER MOLLUSCA: CONSERVATION PRIORITIES AND INDICATOR SPECIES

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Many Australian freshwater invertebrates are widespread but two types of freshwater systems have significant, locally endemic, invertebrate faunas: springs associated with the Great Artesian Basin, and long-term permanent streams in the coastal drainages of SE Australia and Tasmania. Hydrobiid gastropods are characteristic of these habitats and many species occupy very restricted distributions and thus are not amenable to a strictly habitat-based conservation strategy. Hydrobiids appear to be useful indicators of long-term permanent streams and might aid in the identification of areas where other freshwater invertebrates with poor dispersal powers have speciated. Much of the known diversity in hydrobiid snails is in areas afforded little or no protection. Changes to land management practices are required to ensure their survival. ☐*Conservation, biodiversity, indicator species, freshwater, invertebrates, Mollusca, Hydrobiidae, Australia.*

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Although there have been more documented extinctions of non-marine molluscs than of mammals and birds combined (Groombridge, 1992), this circumstance has not been foremost in the conservation debate (Wells, 1986; Ponder, 1992). Of extinct molluscs listed, 22% are freshwater species, mostly from the USA. Freshwater molluscs, however, are severely threatened in many parts of the world. Clarke (1970) estimated that about half of the species in the USA was either close to extinction or extinct. The next edition of the *IUCN Red List* will include 285 extinct land and freshwater molluscs, compared with 191 in the 1990 edition.

Australia lacks the obvious, spectacular radiations of freshwater faunas seen, for example, in the Mekong River (Brandt, 1974; Davis, 1979), the Americas (Burch, 1975, 1982) and in some ancient lakes (Boss, 1978). So, is there a problem with the conservation of our freshwater molluscs? Non-marine molluscs are often vulnerable to habitat destruction or disturbance: many have very restricted distributions, for example, camaenid land snails (e.g. Solem, 1988). Similarly, some species of aquatic molluscs, especially hydrobiid snails, are very restricted — species are often found only in one spring or a few closely adjacent ones, notably in arid environments (e.g. in the Americas [Hershler, 1985; Hershler & Sada, 1987] and Australia [see below]). In hydrobiids, marked local genetic differentiation, including speciation, can occur within discontinuous habitats a few kilometres in extent, even in areas of high rainfall such as at Wilsons Promontory in southern Australia (Ponder & Colgan, 1992; Colgan & Ponder, 1994).

Locally restricted species can undergo rapid extinction following habitat destruction (e.g. the land snail genus *Achatinella* in Hawaii [Hadfield, 1986; Solem, 1990]) or following the introduction of new predators (e.g. Clarke et al., 1984). In all, it is clear that highly restricted populations are generally more vulnerable than widespread taxa. Small streams and springs in SE Australia are under threat from activities including agriculture, forestry and damming. In many areas, there are hydrobiid species (and perhaps other aquatic invertebrates) that are very limited in distribution but are presently not recognised as restricted because they are undocumented and/or unnamed. During fieldwork, many situations have been observed where species are so restricted in their ranges that even a small, local development (e.g. farm dam) could have a serious impact or even contribute to the species' extinction.

LOCALISED SPECIATION

Invertebrates with poor dispersal capabilities restricted to permanent, isolated aquatic habitats, sometimes speciate readily. In many parts of

Australia such permanent waters are uncommon but often contain unusual, endemic invertebrate faunas. Investigations on the most speciose group of freshwater snails (Hydrobiidae) revealed an unexpectedly large fauna of local endemics in south eastern Australia, Tasmania (Ponder et al., 1993), Lord Howe Island (Ponder, 1982) and in artesian springs in northern South Australia and western Queensland (see below). Many species are confined to very restricted habitats — for example, a single watershed, a few (or even single) springs or a single, small coastal creek. More than 90 Australian hydrobiid taxa will be included in the new edition of the *IUCN Red List*, none having been listed previously (IUCN Conservation Monitoring Centre, 1988), and many others are still unnamed.

It is almost impossible to make informed judgements about the taxonomy, speciation patterns and management of these localised populations without data on population genetics (see Daniell, 1994). Consequently a program was commenced with Dr D. J. Colgan, to investigate the basic genetic structure of hydrobiid populations in three locations with different habitat types: Wilsons Promontory (Victoria) and the artesian springs of Lake Eyre (South Australia) and Dalhousie (see Colgan & Ponder, 1994). The latter two spring systems exhibit very different historical, limnological and topographic characteristics.

Among 75 Wilsons Promontory hydrobiid populations examined, four genetically distinct, sympatric species in an area only 15km in maximum extent were identified using allozyme electrophoresis (Ponder et al., 1994b; Colgan & Ponder, 1994). With one exception, these species were morphologically indistinguishable. Observations based on morphology alone indicate that considerable speciation has occurred in other areas of SE Australia and Tasmania (Ponder et al., 1993) and the discovery of many cryptic species is likely using genetic techniques.

There is evidence that extinctions (probably many) have occurred throughout SE Australia, primarily due to land clearing for agriculture and towns. However, in areas where even small patches of original vegetation have been maintained around water sources, faunas have often persisted — an indication that there is some hope of long term survival with minimal management.

INDICATOR SPECIES IDENTIFYING AREAS OF ENDEMISM

Many of Australia's lakes and rivers dried during aridity induced by the last glaciation. De Deckker (1986) argued the Australian aquatic fauna was adapted to an environment requiring good dispersal mechanisms. Some long-term water bodies such as artesian springs, however, provided refuges for animals with poor dispersal capability and no effective desiccation-resistant stage in their life cycles. It follows that such animals can be used to identify the water bodies that contained permanent water throughout much of the Pleistocene and Holocene.

Australian freshwater invertebrates that are poor dispersers and lack the ability to withstand even short term desiccation at any stage of their life cycle include some flatworms, amphipod and isopod crustaceans and hydrobiids. Such animals tend to be (with some exceptions) associated with long-term permanent aquatic habitats and could be used as indicators of such habitats. Because such habitats have been in existence for long periods of time, and because they are often isolated from one another, they are much more likely to contain endemic species than more ephemeral bodies of water.

CONSERVATION OF INVERTEBRATES WITH LIMITED RANGES

Discussion on conservation of Australia's aquatic fauna has largely focused on vertebrates (e.g. Michaelis, 1986). Although many invertebrates will be incidentally catered for in the reserves created with other conservation aims (e.g. scenery, trees or vertebrates), additional measures are required for invertebrate conservation (Wells, 1986; Solem, 1990; Yen & Butcher, 1992). Small patches of forest can provide important habitats for molluscs and other biota (e.g. Bouchet, 1990; Meave et al., 1991), including small vertebrates such as frogs, although generally inadequate for larger vertebrates. Such habitats do not have to be formal reserves. A change in land care culture would make a big difference if remnant forested gullies, for example, are treated as an asset. Maintenance of stream-side vegetation not only helps protect aquatic and terrestrial habitats but maintains water quality and prevents erosion.

Resource utilization by humans is a common cause of habitat destruction and the conflicts arising from such use are major impediments in land conservation. I will now briefly outline examples from two very different freshwater ecosystems to illustrate the fragility of these environments and problems arising from utilization of their resources.

SPRINGS OF THE GREAT ARTESIAN BASIN

Access to artesian water is considered a fundamental right for anyone utilizing arid lands in Australia. However, artesian water is also essential to the continued existence of more than 40 species of aquatic invertebrates that live in unusual and biologically unique natural springs.

Artesian springs in arid areas around the world contain relictual and endemic biota (Cole, 1968). The Great Artesian Basin (GAB) — 22% of the area of Australia — has numerous artesian springs on its fringes (see overviews by Ponder, 1986; Zeidler & Ponder, 1989; Boyd, 1990) and are the only natural sources of permanent water in this mainly arid area. While the South Australian springs have gained some attention from conservationists (see Harris, 1981, 1993), other important springs in western Queensland (Ponder, 1986; Ponder & Clark, 1990) have been largely ignored. Many of the GAB springs — often called 'mound springs' — contain rare flora, endemic fishes and invertebrates (Mitchell, 1985; Ponder, 1985, 1986). Many of them, however, have ceased to flow in the last one hundred years because of water extraction from the Basin, and most of the remaining springs are under threat. Only one spring group in South Australia and one very minor group in Queensland are protected. The remainder are on pastoral land.

The hydrobiid snails are the most speciose invertebrates of GAB springs with three separate radiations in mainly endemic genera. Two are in South Australia: one near Lake Eyre (two genera) (Ponder et al., 1989), the other in Dalhousie Springs (Ponder, 1989); and a third is in western Queensland (Ponder, 1986; Ponder & Clark, 1990). Other interesting, relict endemic invertebrates include a macrostomid flatworm and ostracod, isopod and amphipod crustaceans (see Ponder, 1986 for summary). The endemic genera, even subfamilies, in some groups of artesian springs suggest that they are relicts of a now mostly extinct, early Pleistocene or late Tertiary inland freshwater fauna (Ponder, 1986; De Deckker, 1986) or possibly an older fauna associated with artesian springs of the Tertiary.

Biological information, including data on population genetics, is needed to provide a basis for management. Even though these small springs are often widely separated by arid countryside, preliminary studies on the genetic structure of hydrobiid populations have shown that the levels of gene flow between springs are actually higher than between small streams on Wilsons Promontory in moist, temperate south eastern Victoria (Colgan & Ponder, 1994). This might be largely due to differences in the accessibility of these habitats to birds, which act as primary dispersal agents (Ponder et al., 1994b).

The heavy usage of artesian water over the last hundred years has caused the extinction of many springs (Ponder, 1986) and, with them, their aquatic biota. Nearly all artesian springs in NW New South Wales are now dry as are many in Queensland, particularly in the western, northern and southern parts of the basin. In some areas, the few remaining springs are so reduced in flow they are highly vulnerable to stock damage. Consequently, the extinctions of the fauna they contain appear to be inevitable.

Legislated protection of all spring groups known to contain endemic faunas is essential and overdue. This action, however, must also be coupled with proper management and conservation of artesian water if the springs are to continue to exist and their endemic biota survive.

WESTERN TASMANIA

One might assume that a very wet area provides an environment conducive to the dispersal of freshwater invertebrates. This is not necessarily a correct conclusion. In the larger rivers of western Tasmania, up to 80-90 macroinvertebrate taxa can be expected in the riffle zones (Richardson & Swain, 1978) — and this figure is similar to those found in rivers in Victoria and in other parts of Tasmania. Some invertebrate groups (summary in Ponder et al., 1994a), such as insects, crustaceans and molluscs are well known and also show high levels of endemism (Williams, 1974; Campbell, 1981; Ponder et al., 1994a).

Aquatic molluscs have generally been regarded as a minor, uncommon component of the fauna (e.g. Malcolm, 1987; Chilcott, 1987). Recent studies, however, show that many species of snails of the world-wide Hydrobiidae are found in Tasmanian lotic systems and, occasionally they are locally very abundant (e.g. Coleman, 1978). Many, perhaps unexpectedly, have restricted distributions (Ponder et al., 1993) and some species are apparently restricted to single streams or springs.

Species in most other Tasmanian freshwater mollusc families also have wide distributions

(Smith & Kershaw, 1981) but there are a few exceptions. These include an unnamed lymnaeid gastropod so far found only in the lower section of the Franklin River. (Had it not been for the successful campaign to prevent the damming of the Franklin River this species — and several locally restricted hydrobiids — would now undoubtedly be extinct). The large limpet-like planorbid, *Ancylastrum*, is listed as endangered (Michaelis, 1986) and occurs in a few lakes in central Tasmania where it is severely threatened by hydro-electric developments and predation by trout.

While a significant proportion of western Tasmania falls within the World Heritage Area, very diverse faunas are also found in the mainly unprotected northwest and north coast drainages. Even within protected areas, exotic fishes that feed on native fishes and invertebrates can become established and almost impossible to control. This also applies to exotic competitors such as the introduced hydrobiid *Potamopyrgus antipodarum* (Ponder, 1988).

The damming of rivers or clear-felling of forests has dramatic affects on localised invertebrates by destroying or markedly altering habitats in catchments. Downstream impacts on invertebrates from developments such as dams (e.g. King & Tyler, 1982 for the Gordon River below Gordon Dam) or mines (e.g. in the King River, Lake et al. [1977] and Swain & White [1985]) can also be considerable.

Lotic habitats in the main are more likely to contain endemic species because of the recent origin of most lakes. The destruction of Lake Pedder in 1972 by hydro-electric 'development' rightly caused anguish but, in all probability, the now drowned streams previously feeding the lake contained more animals that were unique. However, in spite of the high profile of the controversies about dams, other activities such as forestry, and particularly agriculture, continue to have the greatest destructive impact on freshwater biota.

Michaelis (1986) and others have stressed the need for habitat conservation, rather than the individual species approach. Whereas habitat conservation is very important, if our aim is to conserve maximum diversity, the identification of significant areas of endemism must also be pursued. Such areas exist through a combination of local physical and historical factors and can be overlooked by using a strictly habitat-based approach.

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